Brain Plasticity Related to Psychomotor Skills in Catheter-based Interventions

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Introduction

- A fascinating property of the human brain is its ability to reorganize as a result of experience
- Experimental evidence of practice-related brain change has been shown as a result of various training tasks and time schemes
- However, complex, delicate real-life tasks that involve multiple interrelated skills have not been examined yet

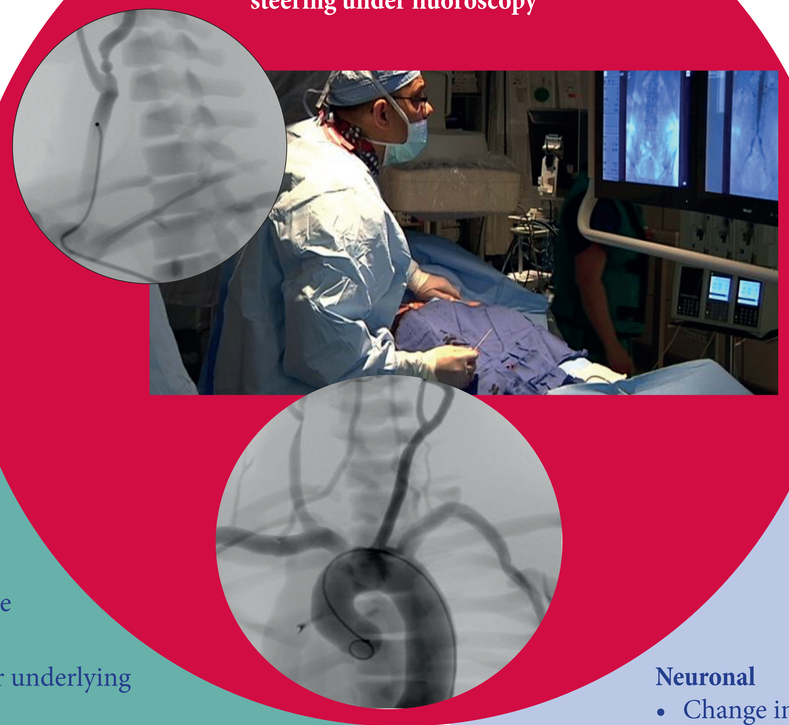
Endovascular Procedures

- Minimal access procedures, where a catheter is used to treat cardiovascular disease
- These procedures are cognitively challenging

Psychomotor Challenges

- Neither direct access, nor direct view to the target site
- X-ray visualization is imperfect, proprioceptive illusions
- Patient anatomy and morphology can complicate catheter steering

Operator conducting an endovascular procedure. The circles show catheter steering under fluoroscopy



Research Questions

- Does training of the psychomotor skills related to catheter-based procedures cause grey and white matter change as well as increased functional connectivity? Is it behaviourally relevant ?

Hypothesis

- Grey matter change in the experimental group is mainly expected in the medial occipital and parietal lobe; other areas will be explored
- Increased fractional anisotrophy is mainly expected in the white matter underlying the right posterior intraparietal sulcus; other areas will be explored
- Increased functional connectivity is expected in fronto-parietal networks and cerebellar networks

References

Lanzer, P. (2013). Cognitive and decision-making skills in catheter-based cardiovascular interventions. In Catheter-Based Cardiovascular Interventions (pp. 113-155). Springer Berlin Heidelberg.

Scholz, J., Klein, M. C., Behrens, T. E., & Johansen-Berg, H. (2009). Training induces changes in white-matter architecture. Nature neuroscience, 12(11), 1370-1371.

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Methods

- Participants: Forty (20 controls) healthy undergraduate medical students

PROCEDURE

DAY 1

MRI Pre-Measures

Cognitive Tests

DAY 2

Video Instruction

Training on the Simulator

DAY 3

Psychomotor Training on Mentice VIST G5 Simulator

MRI Post-Measures

Psychomotor Training

Participants will train attaining access to the internal carotid artery on the endovascular simulator VIST G5 (Mentice, Gothenburg). The complexity of the training cases will increase after a predefined skill level is mastered

Measures

Behavioural
- Movement economy
- Catheter handling errors
- Radiation exposure and amount of contrast agent used

Neuronal
- Change in grey matter (T1-weighted scan)
- Change in white matter (diffusion weighted scan)
- Change in functional connectivity (resting-state fMRI)

Cognitive
- Mental rotation skills, task-switching ability and cognitive control

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